

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



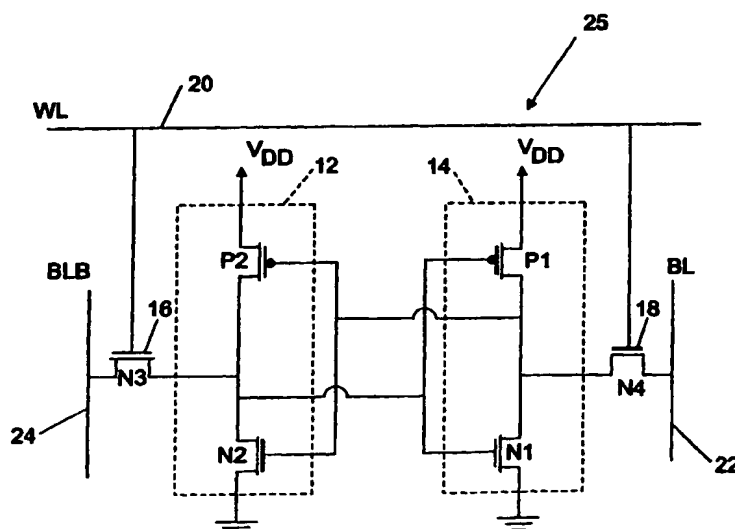
(43) International Publication Date
19 February 2004 (19.02.2004)

PCT

(10) International Publication Number
WO 2004/015711 A2

- (51) International Patent Classification⁷: **G11C**
- (21) International Application Number:
PCT/US2003/025084
- (22) International Filing Date: 8 August 2003 (08.08.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
60/402,275 9 August 2002 (09.08.2002) US
- (71) Applicant (for all designated States except US): **THE GOVERNING COUNCIL OF THE UNIVERSITY OF TORONTO** [CA/CA]; 27 King's College Circle, Simcoe Hall, Room 133S, Toronto, Ontario M5S1A1 (CA).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **NAJM, Farid, N.** [US/CA]; 3126 Workman Drive, Mississauga, Ontario L5M6K5 (CA). **AZIZI, Navid** [CA/CA]; 5 Montgomery Court, Markham, Ontario L3R 0C4 (CA). **MOSHOVOS, Andreas** [GR/GR]; Prousis 9, GR-104 40 Athens (GR).
- (74) Agent: **STEPHENS, Gregory, A.**; 2200 West Main Street, Suite 800, Durham, NC 27705 (US).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:**
— without international search report and to be republished upon receipt of that report
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: LOW LEAKAGE ASYMMETRIC SRAM CELL DEVICES.



(57) **Abstract:** Asymmetric SRAM cell designs exploiting data storage patterns found in ordinary software programs wherein most of the bits stored are zeroes for data and instruction streams. The asymmetric SRAM cell designs offer lower leakage power with little impact on latency. In asymmetric SRAM cells, selected transistors are "weakened" to reduce leakage current when the cell is storing a zero. Transistor weakening may be achieved by using higher voltage threshold transistors, by varying transistor geometries, or other means. In addition, a novel sense amplifier design is provided that leverages the asymmetric nature of the asymmetric SRAM cells to offer cell read times that are comparable with conventional symmetric SRAM cells. Lastly, cache memory designs are provided that are based on asymmetric SRAM cells offering leakage power reduction while maintaining high performance, comparable noise margins, and stability with respect to conventional cache memories.